0022-5347/05/1733-0705/0
THE JOURNAL OF UROLOGY®

Vol. 173, 705–708, March 2005
Printed in U.S.A.
DOI: 10.1097/01.ju.0000146270.65101.1d

Historical Article

A HISTORY OF PARTIAL NEPHRECTOMY FOR RENAL TUMORS

HARRY W. HERR*

From the Department of Urology, Memorial Sloan-Kettering Cancer Center, New York, New York

ABSTRACT

Purpose: This article records the history of nephron sparing surgery for renal tumors.

Materials and Methods: Multiple biomedical databases were queried. Original sources were reviewed to document the history of partial nephrectomy.

Results: For more than a century partial nephrectomy evolved as treatment for renal tumors, first by accident, then rejected as a planned procedure in favor of radical nephrectomy, later in mandatory cases of solitary kidney, poor renal function or bilateral renal tumors and then to an accepted elective procedure in cases with a healthy opposite kidney. Partial nephrectomy became widely accepted only recently for many renal tumors due to parallel advances in tumor biology, radiological imaging and surgical technology.

Conclusions: The history of partial nephrectomy is a timely story setting important precedents for understanding current and future strategies to treat changing patterns of renal neoplasms.

KEY WORDS: kidney, kidney neoplasms, nephrectomy, history of medicine

"Do not be misled by the confident tone of the literature (including my own observations) into confusing opinion with established truth."

Eric Hobsbawm, 1994

Surgery is the cornerstone of treatment for renal tumors. For the last 130 years total nephrectomy was the traditional surgical approach because it removes the primary tumor with a wide surgical margin and most patients have another good kidney. Now partial nephrectomy is as common as radical nephrectomy, even in patients with a normal opposite kidney. This is explained partly by improved renal imaging and better surgical methods. However, technical advances alone do not explain why partial nephrectomy or newer, minimally invasive techniques now being used to treat renal tumors have become viable alternatives to nephrectomy. Instead, surgical approaches to renal tumors have always been determined by biological considerations and clinical presentation. In fact, a biological basis for nephron sparing surgery was established long before modern computerized tomography (CT) and magnetic resonance imaging made such surgery viable. How and why partial nephrectomy evolved from a rare procedure to become a standard operation is the subject of this historical review. It is a timely story rooted in the culture of the past that sets important precedents for current and future strategies adapted to advances in tumor biology and changing patterns of renal neoplasms.

METHODS

Biomedical and related databases were queried including MEDLINE, CANCERLIT, HealthSTAR, PDQ, Cancer Database, Science Citation Index, the National Library of Medicine and the Index-Catalogue of the Surgeons General Office, Washington, D. C. Library archives were available at Nathan Cummings Center, Memorial Sloan-Kettering Cancer Center, Cornell University Medical Center, Rockefeller University, Health Sciences Library at Columbia University and New York Academy of Medicine.

The author reviewed all available articles pertaining to kidney surgery with particular reference to partial nephrectomy. The world literature is voluminous. In the last 2 decades more than 500 articles on partial nephrectomy have been published and many others were published before then. Articles are cited if they illustrate turning points that influenced the history of partial nephrectomy. Others supporting the chronology of partial nephrectomy are only mentioned with the year(s) cited in parentheses after author names to indicate the date of publication or when surgeries were performed.

LATE 19TH CENTURY (1870 TO 1900)

The history of renal surgery had an inauspicious beginning when a whole kidney (Walcott, 1861) and part of a kidney (Spiegelberg, 1867) were mistakenly removed during operations for liver cysts. The 2 patients died. In 1869 Simon successfully performed the first planned nephrectomy to cure a urinary fistula (fig. 1). Largely forgotten is that 1 year later in 1870 Simon also performed the first deliberate partial nephrectomy for hydronephrosis.[1] His epoch making nephrectomy was more significant because it established 2 incontrovertible facts influencing the early history of renal surgery, namely that a kidney could be extirpated safely from the human body and a patient could survive with only 1 kidney. These 2 observations led to the wide use of nephrectomy and dampened initial enthusiasm for kidney sparing surgery.

Nephrectomy gained acceptance slowly among surgeons due to a surgical mortality rate of almost 50% from sepsis. In the last quarter of the 19th century surgeons became armed with the revolutionary new methods of Lister of antiseptic surgery and mortality rates decreased, leading to the steady expansion of renal surgery. By the mid 1880s operations on the kidneys had become so routine that more than 100 cases

Submitted for publication August 10, 2004.
* Correspondence: Memorial Hospital, 1275 York Ave., New York, New York 10021 (telephone: 646-422-4411; FAX: 212-988-0798; e-mail: herrh@mskcc.org).

FIG. 1. Gustav Simon (1824 to 1876) performed first planned nephrectomy in 1869 and first partial nephrectomy in 1870.

of nephrectomy were collected up to 1882, 235 by 1886 and more than 300 before 1900 (55 for tumor) in Europe and the United States combined.[2] Scientific thinking was introduced to surgery, leading to new operations based on anatomical and physiological principles to preserve and reconstruct the kidney.

In 1884 Wells accidentally removed a third of a kidney during enucleation of a perirenal fibrolipoma.[3] Czerny is credited with being the first surgeon to perform deliberate partial resection of a renal tumor (for angiosarcoma) in 1887,[4] 18 years after the first nephrectomy by Simon (Czerny succeeded Simon at Heidelberg) (fig. 2). From 1879 to 1900 extensive experimental studies by Tillman, Tuffier, Bardenheuer, Paoli and others established the feasibility of partial resection for localized kidney diseases.[5] They investigated renal repair mechanisms, compensatory hypertrophy, renal function, changes in body functions and the amount of renal tissue necessary for life after partial resection. Surgeons then began to perform partial nephrectomy in various types of clinical cases but the operation soon lost favor and it was more or less abandoned due to an unwarranted fear of extensive hemorrhage at operation, delayed bleeding following surgery, frequent and persistent urinary fistula following the operation and poor results due to the injudicious use of partial resection to treat neoplasms and tuberculosis of the kidney. Kummell (1890), Bardenheuer (1891) and Block (1895) attempted partial nephrectomy for tumor but their patients died of atrophy of the kidney, shock and uremia. During this early period lumbar nephrectomy became established as the preferred operation for benign and malignant diseases of the kidney.

FIG. 2. Vincenz Czerny (1842 to 1915) performed first partial nephrectomy for renal tumor in 1887.

EARLY 20TH CENTURY (1900 TO 1950)

With the dawn of the new century surgeons began to explore conservative operations for localized, noncancerous diseases of the kidney, such as cysts, benign tumors, infarcts, carbuncles, localized hydronephrosis, or pyonephrosis with or without calculi and renal fistula. As a result, partial nephrectomy gradually supplanted total nephrectomy for the treatment of these conditions. On the other hand, surgeons continued to believe that total nephrectomy was the only effective treatment for malignant kidney tumors. An exception was Rosenstein (1932), who performed partial nephrectomy to palliate a case of kidney cancer and urged that this operation should be done in similar cases in which the contralateral kidney was incapable of satisfactory function following nephrectomy.

Enthusiasm for conservative surgery for renal tumors was also discouraged by tumor spread into fat around the kidney observed at autopsy or nephrectomy specimens and virtually all patients during this period had symptomatic renal cancers larger than 7 cm. In 1903 Gregoire first reported removing kidney tumors en bloc with the fatty capsule, adrenal gland and adjacent lymph nodes.[6] For the next 50 years transperitoneal nephrectomy was the established operation for malignant renal tumors. Although lumbar nephrectomy was still done, the transperitoneal route was preferred because it was the only way surgeons could verify that a patient had 2 kidneys. Despite aggressive surgery for the times 33% of patients died of disease within 1 year and 65% died in less than 5 years.

In 1937 Goldstein and Abeshouse collected 296 cases of partial resection (1901 to 1935), of which 34 (11%) were done for renal tumors, that is 21 for malignant tumors with 1 death and 13 for benign tumors with no deaths. There were no cases of secondary hemorrhage or urinary fistula reported. They concluded that "small tumors and tumors of moderate size situated at one of the poles of the kidney, may be removed by partial resection out of necessity, but was contraindicated if the opposite kidney was healthy."[7] From 1937 to 1950 Semb (1949) and Dufour (1951) added another 25 cases of partial nephrectomy with similar results, although before 1950 even suspected renal tumors were treated primarily with nephrectomy and only a few cases with poor renal function underwent local excision.[8] Most surgeons regarded partial nephrectomy as technically more demanding than nephrectomy, associated with a higher complication rate and simply unnecessary in most patients.[9]

LATE 20TH CENTURY (1950 TO 2000)

In 1950 Vermooten laid the foundation for modern nephron sparing surgery for renal neoplasms.[10] "There are certain

instances, when, for the patient's well being, it is unwise to do a nephrectomy, even in the presence of a malignant growth involving the kidney. The question is, whether such a procedure is ever justifiable when the opposite kidney is normal. I am inclined to think that in certain circumstances it may be."[10] In 1948 he removed a 10 × 7 cm carcinoma from the left kidney of a 52-year-old woman with a normal right kidney, who died several years later of metastases. His decision was based on pathological studies by Cahill (1948), Beare and McDonald (1949) showing that clear cell carcinomas arose from the cortex, were localized, surrounded by a capsule, grew by expansile growth, rarely invaded surrounding structures and spread primarily by the bloodstream. He was also aware that the autopsy studies of Bell, Shakeen, Hale, Burkland, Kozall and Kirshbaum (1938 to 1944) had revealed few metastases from small renal tumors. For example, Bell reported that only 7% of tumors less than 5 cm had metastases compared with 83% greater than 10 cm.[11] In fact, small tumors rarely broke through the capsule and only 1 metastasis was noted among 38 tumors 3 cm or less. Microscopic studies of tissue adjacent to tumors also persuaded Vermooten that some tumors could be excised with only a 1 cm margin without fear of local recurrence and local tumor excision should be attempted, especially in a solitary kidney or when there was markedly impaired function of the opposite kidney.

Few urologists paid much attention to Vermooten or to the observations of Bell except to argue that, since small tumors might metastasize, that warranted total nephrectomy for all renal tumors (ignoring whether nephrectomy would alter such events), especially in cases with 2 kidneys. During the next 40 years partial nephrectomy was done mostly for tumor in a solitary kidney, poor renal function or bilateral renal tumors. From 1950 to 1967 Zinman and Dowd collected only 18 essential cases of partial nephrectomy, adding 3 of their own. At the same time other progressive surgeons, such as Badenoch (1950), Ortega (1951), Dufour (1951), Szendroi and Babics (1955), Laskownicki (1955), Watts (1955), Gordon (1958) and Hanley (1962), reported individual cases of partial nephrectomy for unilateral renal tumors when the other kidney was considered satisfactory.[12] Still, most urologists believed that partial nephrectomy was unwarranted unless there was a compelling reason to preserve renal function. Textbooks published between 1937 and 1970 do not mention partial nephrectomy.

In 1963 Robson reported initial results in 62 patients treated with modern radical nephrectomy between 1949 and 1960.[13] Although claims of superior survival over simple nephrectomy favored in the past were never substantiated, there is no doubt that the Halstedian approach of Robson to kidney cancer was right for the times. Most patients presented then with large, symptomatic or locally advanced tumors, mandating radical excision of the kidney and adjacent tissues. Radical nephrectomy became established as standard surgical treatment for localized renal tumors and all solid renal masses were considered to be potentially lethal cancers. That attitude would prevail for much of the rest of the century.

Amid a climate of radical surgery the 1960s also saw significant improvements in nephron sparing surgery. Poutasse (1962) improved the surgical technique of partial nephrectomy based on the segmental blood supply to the kidney, and Kerr (1959) and Klotz (1960) introduced renal hypothermia, which prevented ischemic damage, and permitted longer operations and complicated reconstructions of the kidney in a bloodless field. As a result of these surgical advances and the favorable experiences of earlier surgeons, partial nephrectomy began to be done more frequently in essential cases by Novick (1956 to 1976), Smith (1954 to 1961), Kerr (1960), Grabstald (1967), Lytton (1979), Palmer (1963 to 1983), Zincke (1970 to 2000) and their colleagues in the United States, and by Fleming (1964), Semb (1965), Marberger (1967 to 1980), Walquist (1969), Wickham (1954 to 1974), Rocha-Brito (1971), Moll (1975 to 1991) and others in Europe. Some early cases had bench surgery but it soon became clear that most tumors could be excised in situ. The rate of local recurrence in the partially resected kidney was 4% to 10%, reflecting the fact that most patients treated in this manner had large and/or multifocal tumors, but their overall survival was similar to that in patients with disease of similar stage who underwent radical nephrectomy. In 1975 Wickham reviewed the world literature (1954 to 1974) and reported a 5-year survival rate of 72% in 37 patients after partial nephrectomy for tumors in a solitary kidney or bilateral renal tumors.[14] The stage was now set to expand the indications for partial nephrectomy to include patients with a healthy opposite kidney.

In the mid 1970s Puigvert (1976), Herr (1976), Novick (1977), Marberger (1981) and others began seriously to question the wisdom of removing a mostly healthy kidney for a unilateral, localized renal tumor, even in patients with a normal opposite kidney. This was certainly not an original idea. Indeed, Vermooten (1950), Ljunggren (1960) and Semb (1965) had come to similar conclusions a decade or more earlier. In 1976 Puigvert (1947 to 1974) reported 21 cases of elective partial nephrectomy, although he admittedly selected cystic renal tumors and many of his patients were children.[15] Also, in 1981 Engen and Herr removed a 2 cm tumor from the right kidney of a 40-year-old woman with a normal opposite kidney and proposed that partial nephrectomy is a surgical option that was preferable to total nephrectomy for small, incidental renal tumors that would be discovered more often because of the increased use of newly developed CT.[16] In 1977 Novick et al (1956 to 1975) mentioned 4 cases of elective partial nephrectomy in a series of essential cases.[17] Additionally, in 1981 Marberger et al (1967 to 1980) reported a multi-institutional series of partial nephrectomy, including 3 cases in which the opposite kidney was normal.[18] Although from 1979 on a few urologists began to advocate routine elective partial nephrectomy for small renal tumors, the majority of urologists still showed little interest in conservative surgery, apparently believing that what could be done and what should be done were 2 different things. However, that was about to change.

The year 1981 marked the beginning of the era of elective nephron sparing surgery for renal tumors and for the next 2 decades it was hotly debated by the urological community. By the early 1980s all of the important pieces were in place to predict successful partial nephrectomy for many renal tumors, including surgical methods to reconstruct the kidney, renal hypothermia, an increasing number of small cortical tumors detected in otherwise normal-looking kidneys and few local recurrences after partial nephrectomy for tumors in solitary kidneys. Many groups remained skeptical and sometimes even hostile to the idea of removing only the tumor and preserving the diseased kidney when the patient had another perfectly good kidney. The major concern among urologists after partial nephrectomy was the possibility of local recurrence due to inadequate excision or multicentric tumors. In 1988 that fear was amplified by Mukamel et al, when they reported evidence of occult multifocal renal tumors in up to 30% of nephrectomy specimens, which might recur if only the primary tumor were removed. Although this rate would later decrease to around 5%, there was little evidence at the time that such information dissuaded committed surgeons from pursuing elective nephron sparing surgery. However, it strengthened the arguments of those who were philosophically opposed to a conservative approach and it undoubtedly deterred some from performing partial nephrectomy, even for small tumors.

In 1993 Licht and Novick reported early favorable results in 241 cases collected from the literature (1967 to 1991) of partial nephrectomy with a normal opposite kidney.[19] Al-

though average tumor size was less than 3.5 cm and followup was short (3 years), only 2 local recurrences were reported and 95% of the patients survived. Furthermore, improved surgical techniques using the argon beam coagulator and intraoperative ultrasound allowed better resection and lessened serious postoperative complications. The group cautioned that elective nephron sparing surgery was appropriate only for small, peripheral, incidentally discovered renal tumors and they called for long-term outcome data to justify any surgical retreat from time honored radical nephrectomy. Herr (1999) and Fergany et al (2000) later provided 10-year followup on more than 100 patients showing a rare local recurrence and almost 100% survival, especially in those with unilateral tumors less than 4 cm.[20,21] Only then did most urologists widely accept elective partial nephrectomy as a viable surgical option for renal tumors.

THE 21ST CENTURY AND THE FUTURE

In the last 4 years open partial nephrectomy has become a standard surgical approach, accounting for almost half of all operations for kidney tumors. This happened during the last century because of parallel advances in tumor biology, radiological imaging and surgical technology. Besides a historical foundation, 3 recent observations provide other compelling reasons for nephron sparing surgery. The majority of renal tumors are now around 4 cm and are serendipitously diagnosed on CT or magnetic resonance imaging. According the Heidelberg classification (1997) half of them are benign tumors or histological subtypes associated with favorable tumor biology compared with conventional renal cell carcinoma. Also, global renal function appears to be better preserved with 2 rather than only 1 kidney. Such considerations have led to expanding the indications of partial nephrectomy to include centrally located tumors and larger tumors up to 7 cm.

The future of nephron sparing surgery is currently evolving. Minimally invasive laparoscopic and percutaneous energy ablation procedures promise to control renal tumors with far less morbidity and better quality of life than open surgery. There is every reason to believe that such treatments and aims will eventually prove to be successful. Advances in tumor biology and radiological imaging portend a time when a simple needle biopsy or a targeted image will characterize renal tumors at the molecular level to identify those who need or do not need treatment. This will assume greater importance in the future to deal with the increasing incidence of renal tumors in an aging population.

In 1950, Abeshouse said it best. “Few procedures provide the urologist with more satisfaction than those that preserve renal function.” If we want to see into the future, we need only look to the past.

Anne Robbins, Nathan Cummings Medical Library, Memorial Sloan-Kettering Cancer Center provided invaluable assistance.

REFERENCES

1. Simon, G.: Chirurgie der Nieren. Stuttgart: Ferdinand Enke, vol. II, p. 314, 1876
2. Gross, R.: Nephrectomy: its indication and contraindications. Am J Med Sci, **90:** 79, 1885
3. Wells, S.: Successful removal of two circum-renal tumours. Br Med J, **1:** 758, 1884
4. Herczel, E.: Uber Nierenextirpation. Bietr Klinich Chirurg, **6:** 485, 1890
5. Newman, D.: History of renal surgery. Lancet, **23:** 149, 1901
6. Gregoire, W.: Les propagations du cancer du rein. Bull Med Soc Anat (Paris), **78:** 764, 1903
7. Goldstein, A. E. and Abeshouse, B. S.: Partial resections of the kidney. A report of 6 cases and a review of the literature. J Urol, **38:** 15, 1937
8. Wharton, L. R.: Hypernephromas that are too early to diagnose. J Urol, **42:** 713, 1939
9. Hess, E., Roth, R. B., Kaminsky, A. F. and Swick, H. V.: Surgery for the conservation of renal parenchyma. J Urol, **64:** 175, 1950
10. Vermooten, V.: Indications for conservative surgery in certain renal tumors: a study based on the growth pattern of the clear cell carcinoma. J Urol, **64:** 200, 1950
11. Bell, E. T.: A classification of renal tumors with observations on the frequency of the various types. J Urol, **39:** 238, 1938
12. Fleming, J. P. and Ward-McQuid, N.: Partial nephrectomy for renal adenocarcinoma in a solitary kidney. Br J Urol **36:** 313, 1964
13. Robson, C. J.: Radical nephrectomy for renal cell carcinoma. J Urol, **89:** 37, 1963
14. Wickham, J. E.: Conservative renal surgery for adenocarcinoma. The place of bench surgery. Br J Urol, **47:** 25, 1975
15. Puigvert, A.: Partial nephrectomy for renal tumours: 21 cases. Eur Urol, **2:** 70, 1976
16. Engen, D. E. and Herr, H. W.: Conservative management of a renal adenoma vs adenocarcinoma. Br J Urol, **53:** 378, 1981
17. Novick, A. C., Stewart, B. H., Straffon, R. A. and Banowsky, L. H.: Partial nephrectomy in the treatment of renal adenocarcinoma. J Urol, **118:** 932, 1977
18. Marberger, M., Pugh, R. C., Auvert, J., Bertermann, H., Costantini, A., Gammelgaard, P. A. et al: Conservative surgery of renal carcinoma: the EIRSS experience. Br J Urol, **53:** 528, 1981
19. Licht, M. R. and Novick, A. C.: Nephron sparing surgery for renal cell carcinoma. J Urol, **149:** 1, 1993
20. Herr, H. W.: Partial nephrectomy for unilateral renal carcinoma and A normal contralateral kidney: 10-year followup. J Urol, **161:** 33, 1999
21. Fergany, A. F., Hafez, K. S. and Novick, A. C.: Long-term results of nephron sparing surgery for localized renal cell carcinoma: 10-year followup. J Urol, **163:** 442, 2000